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# The Assaying Procedure

## Before ore is removed from our mines, samples are taken, prepared and sent to the S.G.S. assay laboratory to determine the gold and silver content.

The data generated is then used to map out which areas are suitable to process as ore and which areas are waste material that will be used to build the waste rock embankment.

The method used is the cyanide extraction process where a portion of the sample has a cyanide solution added to it. This is mixed in a ringmill, the slurry formed is removed, placed into a vial and centrifuged. The supernatant liquid is then aspirated into an AA spectrophotometer to determine gold content.

### In Process Testing

Throughout the extraction process, samples of solution, solids and activated carbon are removed for analysis to determine the efficiency of the process.

The solids and the carbon samples are analysed by the fire assay technique for gold and aqua regia for silver. The solutions are simply aspirated into an AA spectrophotometer.

Fire assay involves adding a ground portion of the solid (or carbon) to a crucible containing a flux. Flux is used to lower the melting point of the samples to ensure the entire sample becomes liquid during firing. The flux contains borax, soda ash, silica flour, litharge (lead oxide) and silver nitrate in various quantities.

In the firing stage everything turns liquid and the lead oxide forms into small globules of metallic lead. The globules fall through the liquid and form an amalgam with any other metals it comes into contact with including gold and silver. This all collects in the bottom of the crucible.

After about an hour at 1,000$^{o}$C the contents of the crucible are poured into a conical mould to cool. Again the lead, being more dense than other material, quickly settles to the tip of the conical mould and solidifies along with the glass-like rock remains.

When cooled, the lead is separated from the glass and then cupelled. Cupellation involves placing the lead 'button' into a pre-heated cupel at 1,000$^{o}$C. A cupel is a small cup made of magnesium sulphate which is a material that is capable of absorbing the lead.

At this temperature the metals liquify and lead is absorbed into the cupel. Gold and silver having a higher surface tension than lead, is not absorbed and remains as a small 'prill' in the bottom of the cupel. The cupel and prill are removed from the furnace and allowed to cool. The prill is then dissolved in aqua regia.

The resulting solution again is aspirated into an AA spectrophotometer to determine the gold content.

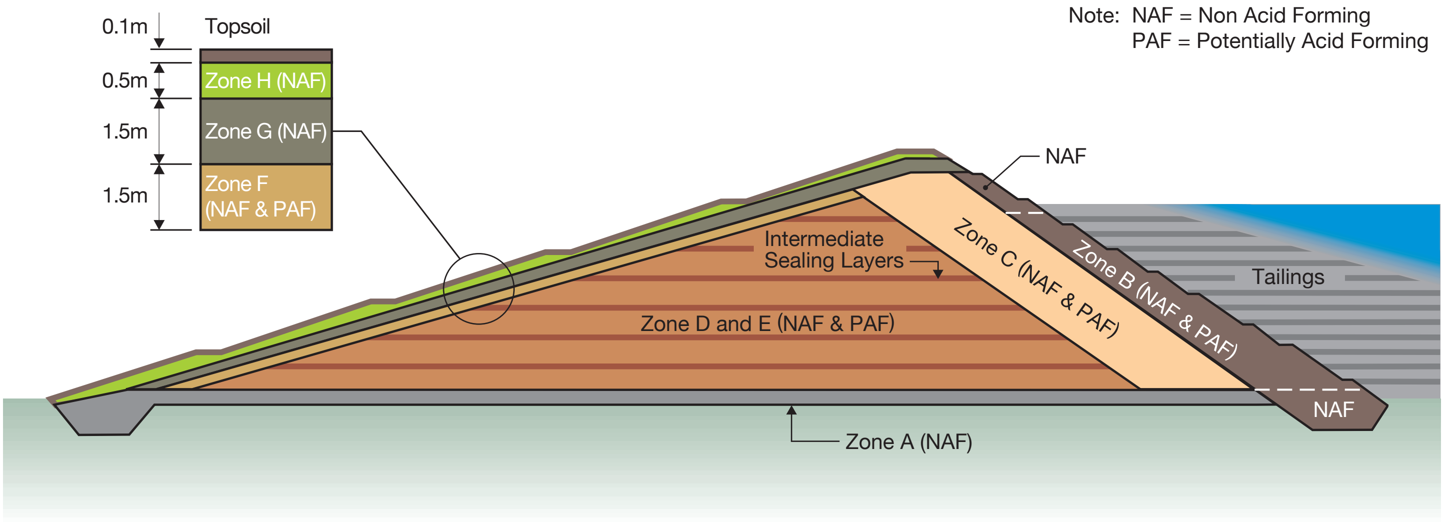
Silver in the solids and carbons is determined by dissolving the sample in aqua regia, a mixture of hydrochloric and nitric acids. The sample has specific volumes of each acid added, then is placed on a heating block to digest.

When completed the resulting solution is diluted and then aspirated into an AA spectrophotometer.

*Fire assay in progress at SGS Laboratories in Waihi.*

DesignShed Ltd. Jan 2012. File: ED CNTR assay procedures OS.indd

# Embankment Structure - Typical Cross Section




## Acid Generation Management

The waste rock embankments are designed as earth/rockfill water-retaining structures and their construction requires the selective placement and zoning of waste rock fill. Embankment zoning provides for:

- restriction of tailings seepage
- safe long-term stability
- control of generation of acid drainage
- collection of seepage and waste rock leachate for treatment
- rehabilitation of the shoulder to pasture and native plantings.

Due to potentially acid forming (PAF) rock, special construction measures are required. PAF material is placed upon a low permeability underblanket and drains collect any leachate. Limestone is applied to exposed PAF rock to control acid generation. Long term acid leachate generation is prevented by isolating PAF rock from oxygen using a special layer (Zone G) on the outside of the embankment.

Zone A
Forms the base underblanket, upstream cutoff and downstream cutoff of the embankments. It is 1.5m thick and is built using materials that have no acid generating potential.

Zone B
Forms the upstream structural shoulder of the embankments. Both NAF and PAF rock may be used. This zone controls seepage from the tailings as well as contributing to strength.

Zone C
Forms the remainder of the upstream structural portion of the embankments, and forms a transition between Zones B and D. PAF material may be used.

Zone D
Forms the bulk of the embankments, contributing to strength and allowing disposal of a large volume of waste rock. Zone D may comprise of different source materials, including PAF.

Zone E
These subcompartments of Zone D are the softest and wettest waste rock, unsuitable for usein Zone D. They are located in areas where the embankment slopes are flattest and well away from the downstream toe. Zone E rock is placed in lifts less than 2.5m thick and the surface is bladed and rolled to achieve a smooth, tight surface to minimise ponding and water infiltration.

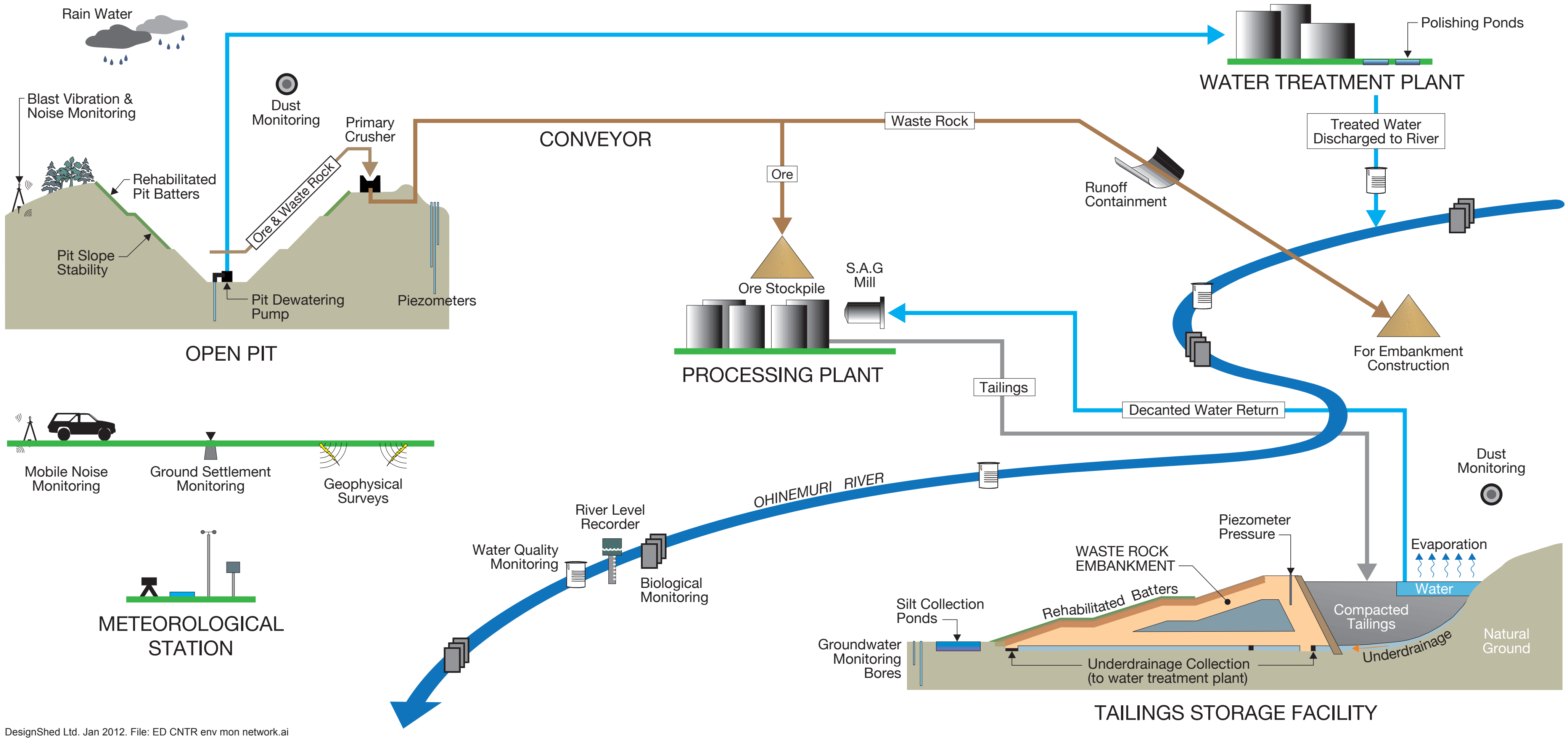
Zone F
Forms a transition zone between waste rock in Zone D and Zone G. It is structural fill (1.5m thick) and may be a mixture of different rock.

Zone G (the cap)
The outer seal layer (1.5m thick) that acts as an oxygen barrier and controls water infiltration. Zone G is built only from NAF rock that has no acid generating potential.

Zone H
Forms the final rehabilitation cover of the embankments. Zone H is constructed from NAF waste rock only. This material is then covered by a topsoil layer in preparation for planting.

DesignShed Ltd. Jan 2012. File: ED CNTR dam cross section.ai

# Environmental Monitoring Network




DesignShed Ltd. Jan 2012. File: ED CNTR env mon network.ai

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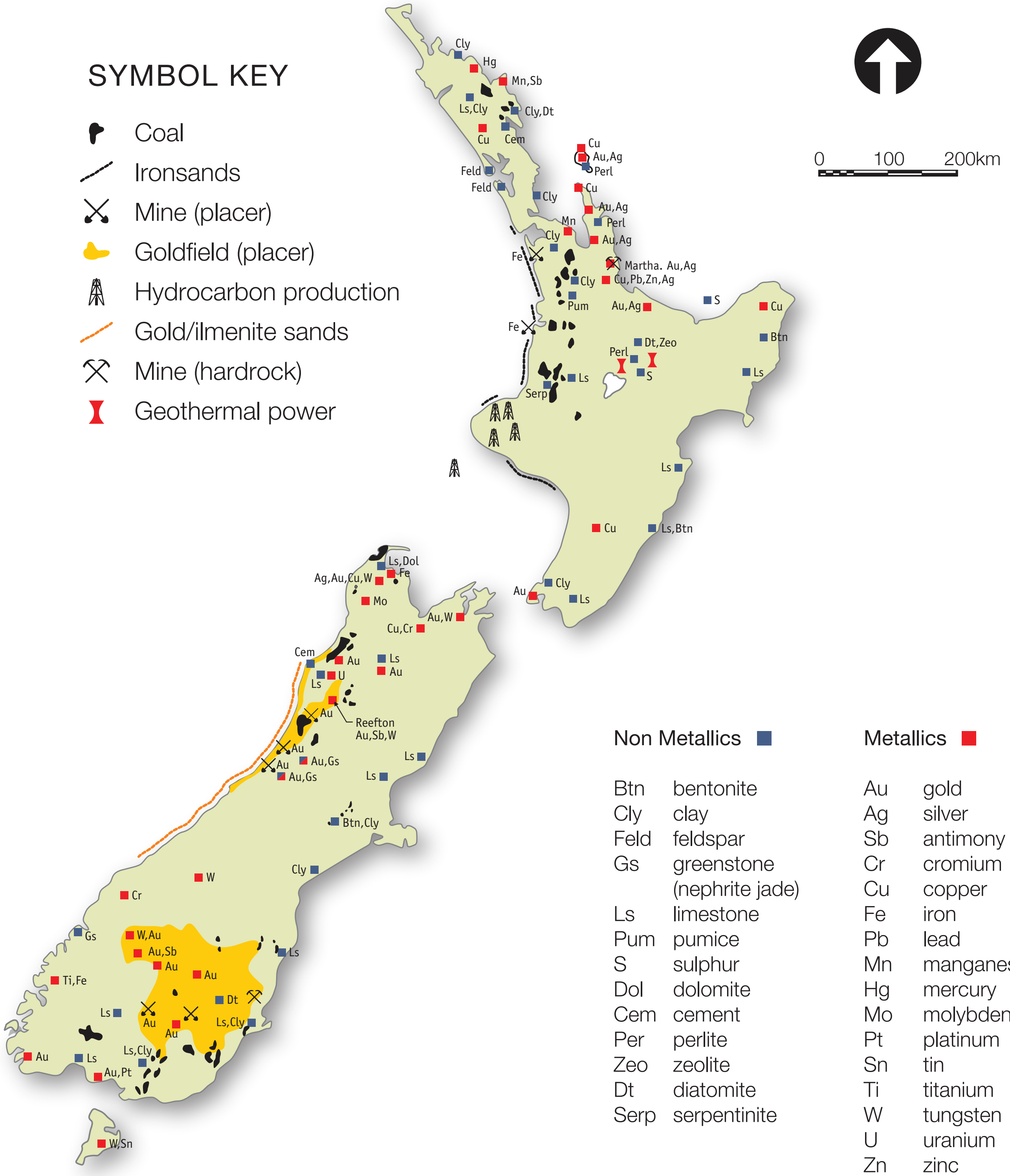
# New Zealand Mineral Deposits




| Non Metallics ■ | |
|---|---|
| Btn | bentonite |
| Cly | clay |
| Feld | feldspar |
| Gs | greenstone (nephrite jade) |
| Ls | limestone |
| Pum | pumice |
| S | sulphur |
| Dol | dolomite |
| Cem | cement |
| Per | perlite |
| Zeo | zeolite |
| Dt | diatomite |
| Serp | serpentinite |

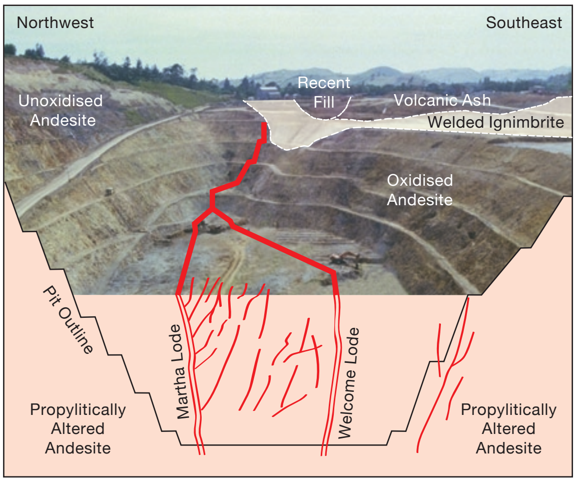
| Metallics ■ | |
|---|---|
| Au | gold |
| Ag | silver |
| Sb | antimony |
| Cr | cromium |
| Cu | copper |
| Fe | iron |
| Pb | lead |
| Mn | manganese |
| Hg | mercury |
| Mo | molybdenum |
| Pt | platinum |
| Sn | tin |
| Ti | titanium |
| W | tungsten |
| U | uranium |
| Zn | zinc |

DesignShed Ltd. Jan 2012. File: Ed Centre resources TEMPLATE.ai

# Martha Open Pit - Geology

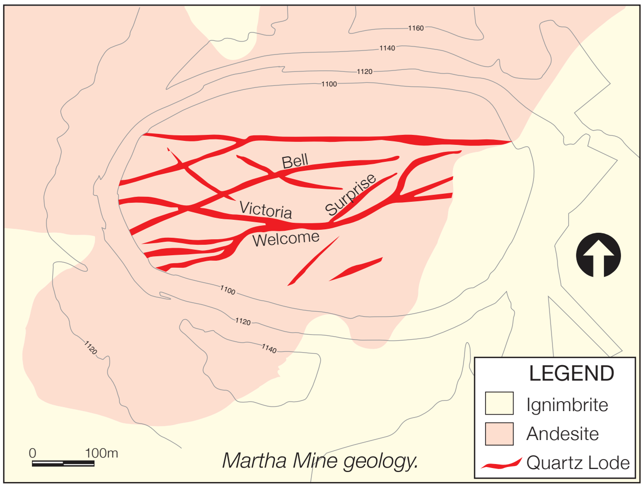
Many millions of years ago (during the Miocene period), a thick sequence of volcanic lavas, breccias and tuffs of generally andesitic composition was deposited to form the bedrock of Waihi and surrounding districts. Some considerable time later earthquake activity formed numerous near-vertical planar fractures in the bedrock which became channels for large volumes of ascending geothermal water. The old land surface high above the present Martha mine during this time would have resembled Rotorua, with hot pools, steaming ground and geysers.

As the dissolved mineral-rich water ascended cooled and the pressure release, many minerals came out of solution. They deposited or crystallized on the sides of the fractures. The predominant minerals were quartz ($SiO_2$) and calcite ($CaCO_3$). Gold and silver crystalized as electrum (Au-Ag alloy), native gold (Au) and acanthite ($Ag_2S$). The geothermal fluids also altered the chemistry of the rocks they passed through, forming minerals like pyrite ($FeS_2$), adularia feldspar ($KAlSi_3O_8$), calcite, chlorite and illite clay.




*Cross section through the Martha Mine.*

Many of these mineralfilled fractures (or veins) intersected to form a complex lattice framework deep underground. The largest vein (Martha Lode) reach dimensions of at least 1.6km long by 600m deep and up to 30m wide.




*Martha Mine geology.*

Millions of years of erosion removed hundreds of vertical metres off the volcanic rock sequence and progressively exposed the quartz vein lattice. Being relatively resistant to erosion, this lattice caused an ancient topographic high. Cold surface ground waters percolating down caused oxidation reactions in the andesite, changing it from a blue-grey to an orange-brown colour through the oxidation of pyrite to limonite.

Extremely violent rhyolitic volcanism during the Pliocene epoch resulted in thick, welded ignimbrite deposits covering the Waihi basin. These filled in old river valleys and probably even covering the ancient Martha Hill. Erosion has continued to lower and shape Martha Hill. Distant volcanism deposited several thick layers of volcanic ash over the area.

The complex myriad of veins within Martha comprises an epithermal gold-silver orebody which is giant by world standards. The larger veins were extensively, but not completely mined out by underground methods between 1878 and 1952. Numerous smaller veins remained untouched by the previous miners and are today able to be extracted by selective open-pit mining methods. Material containing as little as one gram of gold per tonne of rock is able to be mined and milled economically using modern technology.

DesignShed Ltd. Jan 2012. File: ED CNTR pit geology.indd

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# The Cornish Pumphouse

## The Cornish pumphouse is a relic of the original Martha Mine in Waihi - the richest gold mine in New Zealand (I878 - 1952).

Built around 1904 from a design used in the tin mines of Cornwall, England, it housed steam engines and pumping machinery. The pumps were needed to cope with the ever increasing quantities of water as the mine workings followed the gold-bearing quartz reefs to a final depth of nearly 600 metres.

Built by Hathorn-Davy, the horizontal cornish pump was the pride of the New Zealand mining industry. The pump had a stroke of four metres and continuously dewatered the mine workings at a rate of 7,000 litres per minute via the adjacent No5 shaft which was 400m deep.

The pump was used only until 1913 when the Waihi Gold Mining Company completed the first hydro-electric power station on the Waikato River at Hora Hora (now beneath Lake karapiro). The power was brought 100km to the Martha Mine. Electric centrifugal pumps deep in the mine were then used for dewatering.

The Cornish Pumphouse was kept in working order until 1929 as the miners did not trust electricity. By the early 1930s the building was stripped of machinery and left derelict as the mine continued to operate.

In a very impressive feat of engineering, the pumphouse was relocated to its present position in 2006. The building is a landmark for Waihi and a popular visitor attraction. It is Category 1 Historic Places Trust protected.

Height: 21m
Length: 15m
Width: 9m
Weight: 1,840T

DesignShed Ltd. Jan 2012. File: ED CNTR pumphouse.indd

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# The Gold Refining Process

## Dore bullion from the Martha Mine is delivered to the refinery at the Western Australian Mint. Bars are checked, weighed and description recorded in both computer and manual register.

Bars are melted in a 300kw furnace and poured into a pouring pot from which samples are taken for assay use.

The molten material is then cast into ingots which are air cooled, cleaned, labelled, weighed and compared to receival weight to ensure all weights are accounted for.

Assay samples are processed by a dual stream independent procedure to ascertain gold and silver values. These values are applied against the net weight of the total deposit and the resultant calculated gold and silver values are credited to the Waihi Metal Account. Transfers can be made to bullion dealers as financial transactions.

The refiner then completes the refining procedure by placing the ingots (anodes) in vats containing a nitric acid solution and applying an electric charge. The ingot dissolves and the silver content is plated out on a cathode plate. The resultant silver crystal is removed from the cell, washed, dried and melted into the desired form of pure silver.

The gold content is captured in a ‘mud bag’ around the anode, and is washed, dried, melted and refined by a chlorination process. This involves the introduction of chlorine gas into the melting crucible. Gold is separated from the remaining base metals, and is then poured into granules or bars for commercial sale.

DesignShed Ltd. Jan 2012. File: ED CNTR refining process.indd

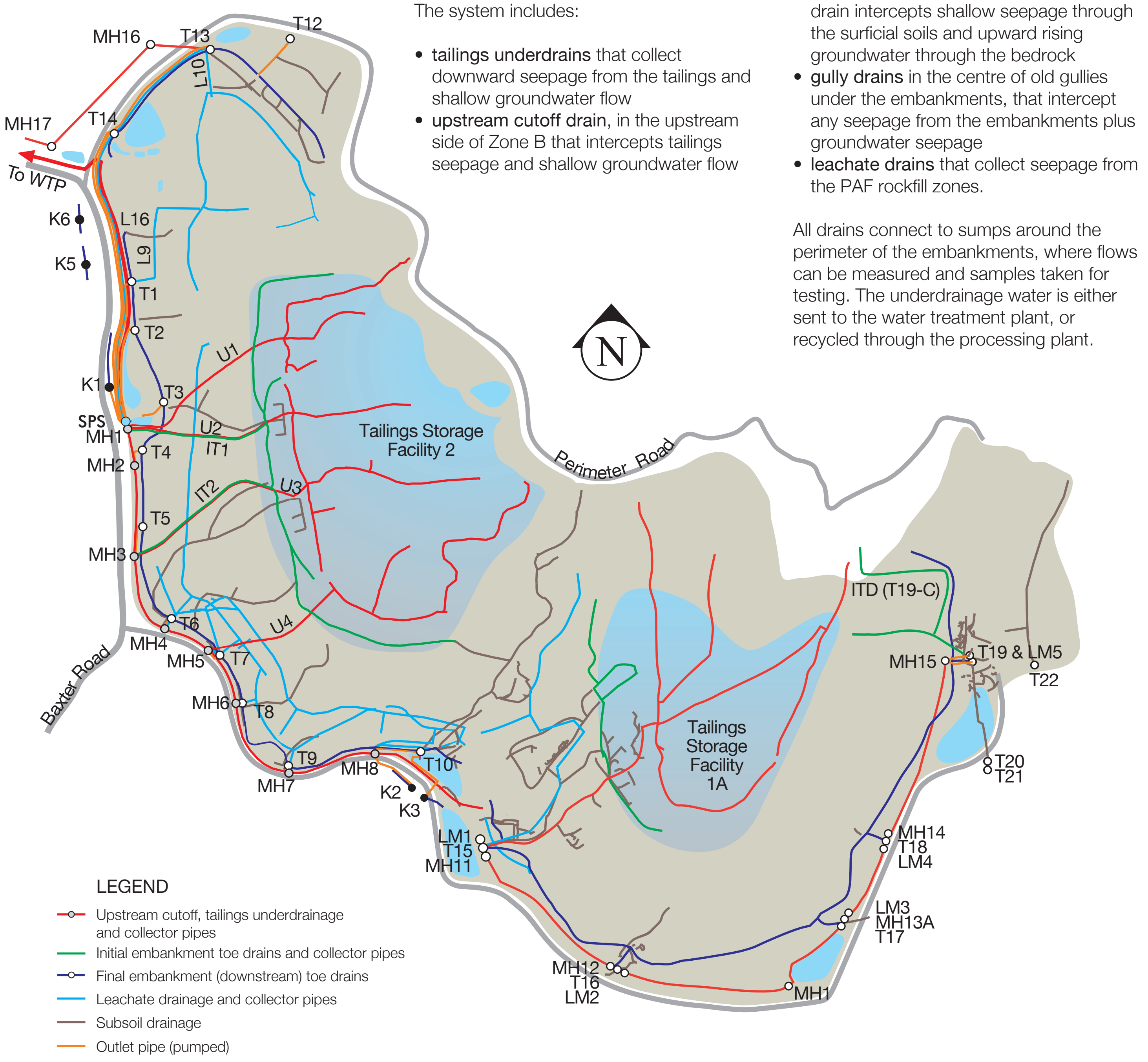
# Tailings Storage Facilities - Underdrainage

## Acid Generation Management

**Subsurface Drainage**
An extensive network of subsurface drainage was built under the tailings ponds and embankments to intercept and control seepage from the tailings, leachate from the embankment and naturally occurring groundwater flows.
The system includes:

- **tailings underdrains** that collect downward seepage from the tailings and shallow groundwater flow
- **upstream cutoff drain**, in the upstream side of Zone B that intercepts tailings seepage and shallow groundwater flow
- **initial toe drain** located along the downstream toe of the first stage of the embankments that intercepts seepage through the bedrock
- **toe drain** located along the downstream toe of the completed embankments: this drain intercepts shallow seepage through the surficial soils and upward rising groundwater through the bedrock
- **gully drains** in the centre of old gullies under the embankments, that intercept any seepage from the embankments plus groundwater seepage
- **leachate drains** that collect seepage from the PAF rockfill zones.

All drains connect to sumps around the perimeter of the embankments, where flows can be measured and samples taken for testing. The underdrainage water is either sent to the water treatment plant, or recycled through the processing plant.




DesignShed Ltd. Jan 2012. File: ED CNTR dam cross section.ai

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# Gold - The Noble Metal

## We rely on Gold and Silver

Throughout history gold and silver have provided artistic inspiration for the creation of jewellery and other art forms. The earliest civilisations realised these metals were not only precious and beautiful, but also versatile and useful. Today we recognise their value to modern technology. They are excellent conductors of heat and electricity. Both can be mixed with other metals to produce alloys with varied uses. They are malleable and ductile, chemically stable by themselves and can be recycled. Gold retains its lustre and will not chip, flake or corrode. Highly polished silver is the best reflector of light and retains its strength despite distortion. In ways we cannot see, these precious metals are being put to work for the benefit of all. In countless ways in our everyday lives we rely on gold and silver.

Gold has the chemical symbol Au from the Latin word for gold, aurum, meaning glowing dawn. The word gold is from the old English word for yellow - GEOLU. Its purity is expressed in carats. Pure gold is 24 carat. The word 'carat' is from the Italian carato, Arabic qirat or Greek keration, all meaning 'fruit of the carob tree'. Ancient traders used carob seeds to balance their scales in oriental bazaars.

Gold:

- is a dense, soft metal. It is the only yellow metal.
- has a relative density of 19.32, nearly twice that of lead.
- has a melting point of 1,064°C.
- has a boiling point of 2,860°C.
- is malleable. Gold leaf can be beaten so thin that light will pass through it. A troy ounce can be beaten into a sheet that will cover an area of 10 square metres.
- is ductile. One troy ounce (31.1g) can be drawn into a wire 0.12 millimetres thick and 80 km long.
- because it does not chip, flake, tarnish or corrode, gold virtually lasts forever. It can be buried, squashed, melted or mixed with other metals. It is still gold.
- is permanent and can be recycled.
- is so rare that only 102,000 tonnes have been taken from the earth in all of recorded history; as much as could be contained in a cube with 19 metre sides.
- more steel is poured in one hour than gold poured since the beginning of time.
- about 10 billion tonnes of gold are estimated to be held in suspension in the oceans of the world. This is 100,000 times more than man has managed to mine from the earth.
- is highly resistant to attack by acids and will not dissolve in any of the common acids, but will dissolve in 'aqua regia' (HCl and HNO) and in alkaline cyanide solutions.
- is the only metal that forms no oxide film on its surface in air at ordinary temperatures.
- exists in minute quantities in our bodies.
- is an excellent conductor of heat and electricity.

### Dentistry

Dentists in the United States use about 30 tonnes of gold annually. Gold alloys, because of their high resistance to corrosion and tarnish and other properties, are used for crowns, bridges, gold inlays and dentures.

### Electronics

The world-wide electronics industry uses about 125 tonnes of gold annually in the circuitry of calculators, television sets, computers, telephones and a host of other products.

### Architecture

An ultra-thin layer of gold deposited on the glass of windows of high-rise office buildings cuts down glare and keeps out the heat-producing infra-red rays from the sun. This reduces air conditioning requirements, without reducing light.

### Medicine

Recent medical research has demonstrated the healing powers of gold. Compounds of gold were first used experimentally in 1927 in the treatment of rheumatoid arthritis and are now the basis of an accepted form of therapy. Radioactive gold is used in the treatment of several types of cancer. Gold leaf is used to treat chronic ulcers as well as in surgery to patch damaged blood vessels, nerves, bones and membranes.

### Aerospace

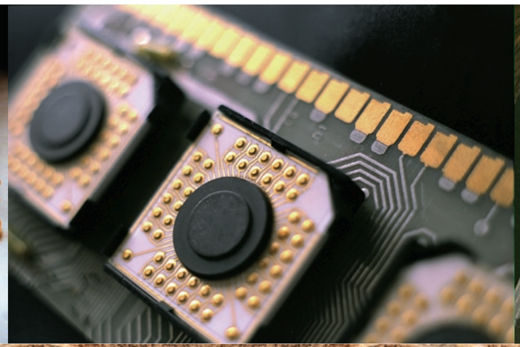
The success of the United States space programme depends heavily on the clean, non-corroding electrical performance of gold. The metal's ability to reflect heat protects astronauts, satellites and critical electronic components from damage by hazardous x-rays and solar radiation found in space.

### Satellites and Communications

Gold is an important component in communications satellites. Satellites send information about weather patterns over oceans and other parts of the world. The data is useful for tracking the paths of tropical storms. Satellites take photos of agricultural changes, such as diseases affecting crops, to predict production each year and help countries plan what they grow for food or trade. Satellites carry 50% of New Zealand's international toll calls. The rest travel by submarine cable. News agencies use satellites to transmit news all over the world. Many television companies transmit news, sports and entertainment programmes direct to viewers via satellite. For navigational purposes, ships and aircraft carry equipment that use satellite tracking to show their position.

### Decoration

Gold was made into jewellery long before it was used as currency. The earliest gold jewellery dates from the Sumer civilisation around 3,000BC. The jewellery was worn by both men and women. Goldsmith's skills that were understood and mastered at that time are still used today, although some of the techniques have been lost. Gold wedding rings, used in marriage ceremonies since the 9th century, date back to the ancient Egyptians. The ring is placed on the third finger of the left hand because it was believed that this finger carried an artery leading directly to the heart. Liquid gold painted on tableware and containers and fired in a kiln produces a lustrous decoration at a very low cost. Gold leaf is used to emboss leather on Bibles, diaries, picture frames and manuscripts. Gold covers the surface of temples, mosques, tombs and statues.


DesignShed Ltd. Jan 2012. File: ED CNTR gold noble metal.indd

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# Silver - Tears of the Moon

## We rely on Gold and Silver

Throughout history gold and silver have provided artistic inspiration for the creation of jewellery and other art forms. The earliest civilisations realised these metals were not only precious and beautiful, but also versatile and useful. Today we recognise their value to modern technology. They are excellent conductors of heat and electricity. Both can be mixed with other metals to produce alloys with varied uses. They are malleable and ductile, chemically stable by themselves and can be recycled. Gold retains its lustre and will not chip, flake or corrode. Highly polished silver is the best reflector of light and retains its strength despite distortion. In ways we cannot see, these precious metals are being put to work for the benefit of all. In countless ways in our everyday lives we rely on gold and silver.

Throughout history silver has played a key role in human affairs. It is found as a free metal in nature so its remarkable properties have been available since the beginnings of civilisation. It kills bacteria, is easily worked, and is a beautiful, sparkling metal. It has a long practical and artistic history. The unique properties of silver find application throughout science and technology. Over 7,000 papers and patents reported in technical and scientific literature each year include silver. In each of these new advances, silver is critical.

Silver:

- is found in most homes, cars, business and factories.
- A silver vase from Chaldea, dated 2,850 BC, is displayed in the Louvre, Paris.
- The Phoenicians used silver vessels for their long voyages because drinking water remained fresh longer when carried in silver than in any other metal or ceramic containers.
- As early as 700 BC. Mesopotamian merchants used silver as a form of exchange.
- The ancient Greeks minted the drachma that contained 4 grams of silver.
- The ancient Roman's basic coin was the denarius, weighing 4.5 grams.
- The Incas of Peru called silver 'the tears of the moon' because they were awed by silver's strange gleam.
- The Chinese believed that a silver locket hung around a child's neck would ward off evil spirits.
- The use of silver to purify water is one of the earliest examples of man controlling his environment.
- The term 'sterling' for English currency denotes a specific weight of silver, which has come to mean excellence.

Although silver is relatively scarce, it is the most plentiful and least expensive of the precious metals.

### Technology

The photographic industry is the largest industrial consumer of silver. From the outset, silver halide has been the material that records what is to be seen. Today's photography has silver halides coupled with dyes that bring the colour of the world around us into a permanent record. Photographic uses alone account for 35% of silver use throughout the world.
Watches, clocks and calculators today are battery driven; silver batteries are the power source of choice. The silver battery provides the higher voltage and long life required for quartz watches. Silver oxide-zinc batteries, which have twice the electrical capacity of lead-acid batteries of the same size, have long found extensive use in aircraft and submersibles, where weight is critical.
Silver has long been used to braze materials together. Its advantageous alloying and wetting properties are especially useful to hermetically seal together the components of electron power tubes such as the radar tubes installed at United States airfields to warn pilots of deadly wind shear, which can cause aeroplanes to crash.

Today under the keys of every personal computer is a panel of switches with silver contacts to carry out flawlessly the countless billions of instructions.
Silver thiosulphate prevents the release of ethylene gas within cut flowers making it possible to market long lasting flowers for export, florist shops and supermarkets.
Silver concentrates sun rays on solar collectors, backs mirrors and protects the heat reflecting gold films on office windows.
It can be prepared as crystals of silver iodine and seeded into cold cloud to become raindrops or snowflakes.

### In the home

Silver will activate oxygen to kill bacteria and thus can be used in swimming pool filters or to purify drinking water. Several millions of water purifiers are sold each year to rid drinking water of bacteria, chlorine, lead, trihalomethanes, particulate and odour. Here silver is used to prevent the build-up of bacteria and algae in the filters.
Microwave cooking is made more appetising due to a silver alloy coating applied to the bottom of microwave cookware, the surface of which will reach $260^{\circ}C$ in five minutes, resulting in a browning or crisping of food surfaces.

### Medicine

Medically, silver and gold are used in the treatment of arthritis where gold can be injected into muscles, and silver is used to coat arthritis pills. Burns are disinfected with silver creams and bones are mended with cement containing antibacterial silver salts.
Silver is used widely in dentistry.
Silver nitrate is administered to new-born infants' eyes to eliminate the incidence of Gonococcal Ophthalmia (a disease causing blindness). In 1968 silver was combined with the powerful chemotherapeutic agent sulphadiazine to produce a drug 50 times more powerful than sulphadiazine alone.
It has become the most widely used drug for treating burn wounds.

Trading houses around the world quote the price of silver, and other precious metals, in terms of troy ounces. One troy ounce equals 31.10348 grams. The term 'troy' is derived from Troyes, France, a major trading city of the Middle Ages.

DesignShed Ltd. Jan 2012. File: ED CNTR silver tears moon.indd

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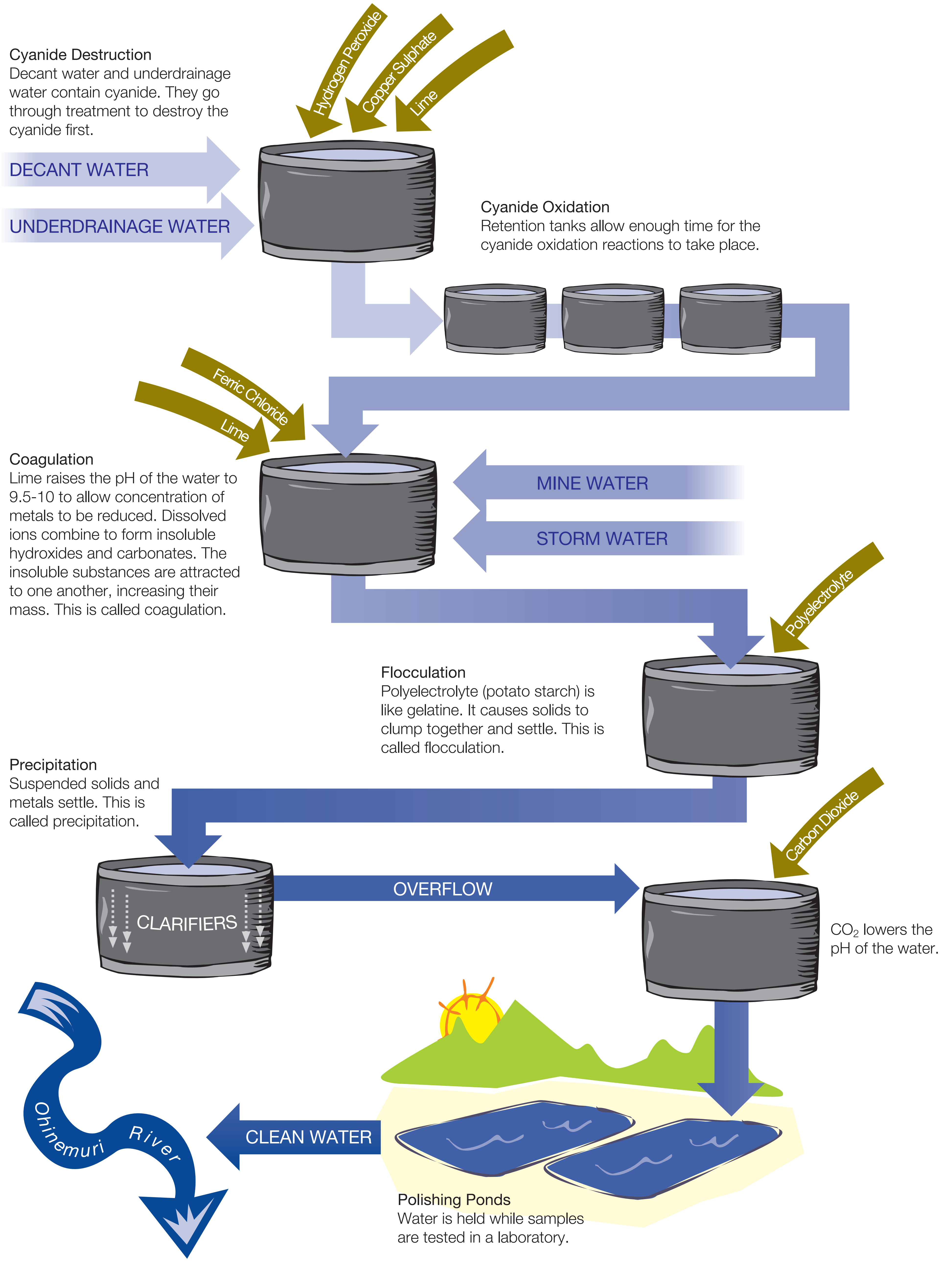
# The Water Treatment Process




DesignShed Ltd. Jan 2012. File: ED CNTR WTP process simpl.ai